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Assistive E-Learning System for the Learning Disabled

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Abstract

Learning Disabilities (LD) are usually hidden disabilities that affect many individuals who usually have average or above average intelligence. It is acquired before, during or soon after birth and affects an individual's ability to learn, all through his/her life. LD may also involve difficulties with organizational skills and social interaction. These difficulties can be alleviated by providing appropriate e-learning environment for them. We had proposed a framework, an Assistive Learning Environment (ALE) to enhance the learning experience of LD students in their academic life[1], which is capable for recognizing what content has to delivered, variability associated with each LD learner and transformations associated with the content to deliver it to the LD learner. The system architecture is developed for our framework whose objective is to transform the given content in a way acceptable by the specific LD learner. This transformation is a complex process and it has to be done at various levels. Assistive E-Learning System, a prototype implementation of our framework has been completed and sample interactions are presented in order to assess the system's strengths and weakness. The system provides the user to indicate transformations and configurations not appropriate to the user.

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Keywords: Learning Disability (LD); special needs; Assistive Learning Environment (ALE); transformations; architecture; e-learning system

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1. E-Learning and Learning Disabilities

In this technological era, e-learning is the link between internet and education. It is a popular educational technique providing promotional path for up gradation and reformation of education in all major countries of the world. However, as far as the students with learning disabilities (LD) are concerned, they often lack the opportunity to get trained via e-learning technology. There is a clear indication that most of the e-learning service providers perceive themselves as mere providers of technology. Consequently, while every technologically possible feature is included in e-learning environment, there is an absence of accessibility integration for LD students. These vendors often contradict themselves, on the one hand, they claim that they provide e-Learning solutions for all [2], but cannot incorporate the needs for LD students. It has become obvious that the impact of not considering the accessibility issues when implementing e-Learning solution will challenge the adaptability process.

LD is a general term that describes specific kinds of learning problems. A learning disability can cause a person to have trouble learning and using certain skills[3]. The skills most often affected are: reading, writing, listening, speaking, reasoning, and doing math states that LD are caused by differences in how a person's brain works and how it processes information[4]. Children with LD are not "dumb" or "lazy." In fact, they usually have average or above average intelligence. Their brains just process information differently. There is no "cure" for learning disabilities[5]. They are life-long. However, children with LD can be high achievers and can be taught ways to get around the learning disability. With the right help, children with LD can and do learn successfully.

The research in the field of providing assistance in learning for LD is still in infancy. In India, around 13 to 14 per cent of all school children suffer from learning disorders. Unfortunately, most schools fail to lend a sympathetic ear to their problems. As a result, these children are branded as failures. Besides the growing awareness, there are still a number of misconceptions that are associated with the term 'learning disabilities'. The reasons for these misconceptions are manifold[6]. The LD movement in India is of a recent origin, there has been an increasing awareness and identification of children with LD. Despite this growing interest, we still do not have a clear idea about such assistance to LD in e-learning environment. Policy related to this assistance for LD is yet to see the daylight. In absence of such a policy and incongruous environment, children with LD cannot be rehabilitated in regular schools[7]. Considering the barriers of LD learner and current scenario of e-learning, we decided to explore this domain of Assistive Learning for LD, trying to address the appropriate technology interventions for their problems.

1.1. Major Challenges

In realizing an Assistive E-Learning System for LD, the major issues and challenges are as follows:

- LD learners often lack the opportunity to get trained via e-learning technology, which provide innovative ways to learn and provide comprehensive interactive access to the content which cater to their requirements and they can learn when and where they want, at their own pace. The aim is to focus on following three dimensions of the e-learning framework: (a) Content (b) Presentation Formats and (c) Pedagogical Strategies through which teaching and learning process can be effectively achieved.
- Content plays a very important role for LD students. Focus is to build appropriate content which can help in building appropriate presentational interventions for LD. The content has to be enriched with text, graphics, audio and video according to the requirement of the LD learners[8]. Currently the content is designed in various formats but are not meant specifically for LD.
- Every LD learner has its own unique learning style. So in order to improve the learning curve, the content must be presented in the format that matches the learning styles of the LD learner[9].
- LD students have wide range of learning needs. They have their own unique set of strengths, weaknesses, interests, experiences and special abilities. Therefore pedagogy that is appropriate for a particular learner in a certain situation may be of little value in another situation[10]. Thus by building pedagogical strategies appropriate for them we can customize their individual learning experience.
- Constructing pre-packaged content for different LD requirements is not feasible, given the wide variety of LD patterns and requirements[11]. A rich and general framework which can transform content from a standard repository to each LD student would be valuable, but challenging to design.
- Also for any e-learning system, there are also typical challenges like delivery, which also apply to our task.

All these issues can be considered as research challenges in the realization of Assistive E-Learning System for LD, in the approach we have adopted.

2. Our Approach

We took assistance of the world of literature. We gain deep insights on the said topic via literature survey. This not only gave us valuable inputs in regards to LD learners, but also showcased several opportunities to assist different types of LD learners. There are many different kinds of LD. Most often they fall into three broad categories like speech & language disorder, academic disorder and other non-verbal disorder[12].

The students affected by LD can have combination of more than one kind. Each of these categories includes a number of more specific disorders. Our focus of survey was specifically for reading disabilities (Dsylexia) with respect to academic disorders only and the findings from these studies is summarized in the table 1.

Table 1. Summarization of Reading Disability

Strength	Weakness	Solutions to their problems
Strong hearing capabilities	Too slow in word recognition and text reading	Screen Readers
Good memorizing power	Mispronunciation of long, unfamiliar, or complicated words	Make use of multimedia course content to make them understand
A good understanding of new concepts difficulty with position in space	Make many mistakes when reading aloud, and repeat and pause often	Smart Word prediction techniques
Learn by experience, not from being told.	Tend to reverse letters, words and experience	Diagrams are easier to interpret if different colors are used to represent the data
Enjoys math	Trouble in following written directions and not oral directions	Usage of mnemonic
Respond well to learning with the "big picture" or overview of everything	Difficulty in learning the names of letters and their associated sounds	Use of graphical representation then text

After our literature survey, it was imperative for us to gain insights into practical aspect of LD learners for us to take our research to the next level. For this we planned to interact, communicate and understand different types of LD learners. For this we visited many institutes and hospitals (names are not disclosed due to agreement issues) and a Student Diagnostic Rating Survey (SDRS) checklist was developed to collect LD student information as shown in fig.1. This SDRS was circulated among students if they were old enough to answer it, else their information was gathered from their class teachers and special educators. The main findings from these visits are explained in subsequent sections. Our findings from several visits to these places are summarized below:

- Our visit to hospitals resulted in our understanding of how a LD student and his type of LD are identified. The students undergo a test and the results showcase the type of LD he/she possess.
- During our visit to special schools, we found out that most of the students we interacted with were aware of their learning disabilities and reasons of attending special schools. They had faced lots of problem while attending regular schools like difficulty in understanding the language of the existing syllabus; they were unable to cope up with the teacher's instructional strategies, faced accessibility issue while studying the course material etc.
- Some of the students were even shy to communicate and fill up the SDRS which was provided by us.
- To get better understanding, we interacted with the teachers/ special educators in detail. They shared the concerns of the LD learners, their learning requirements and the methodology applied by the special

educators to meet the LD learner's requirements.

- The methodology included personalized content, various pedagogical strategies for every LD type and various presentation formats.

Rate LD students on the symptoms listed below using following scale

0	1	2	3	4	NA
Never	Rarely	Occasionally	Frequently	Very Frequently	Not Applicable

Reading difficulty

1. Poor Reader____
2. Do not like reading ____
3. Make mistakes while reading like skipping words or line ____
4. Read same line twice _____
5. Problem in remembering words which are already read _____
6. Words are reverse like dog and god _____
7. Letters are reverse like d and b _____
8. Words tend to move out of page while reading _____
9. Eyes hurt or water while reading_____
10. When reading, difficult to identify the main idea _____
11. Difficulty to read from computer screen_____
12. Usage of Screen Reader_____

Writing difficulty

1. Handwriting messy ____
2. Prefer print chars rather than cursive chars _____
3. Words jumbled up with no space in between _____
4. Poor spelling____
5. Difficult to stay between lines____
6. Difficult to copy from board or from text book ____
7. Problem in grammar or punctuation _____
8. Poor speller____
9. Trouble of putting thoughts into the paper____
10. Can tell a story but cannot write it._____
11. Usage of Keyboard _____
12. Usage of PDA_____

Fig. 1.Student Diagnostic Rating Survey (SDRS)

To sum it up, the practical aspects complimented our literature survey and provided us with relevant data for our Assistive e-learning system which will be explained in the subsequent section.

2.1. System Architecture

We have implemented the system as a web based system, enabling access of the system from anywhere, using just a browser. The architecture is designed as per the framework of ALE [1] and consists of following major modules like: Content Repository, Learner Profile, Assistive Learning Engine, Transformation Base, Learner Goals and Monitoring Module. These components are shown in Fig. 2 and explained as follows:

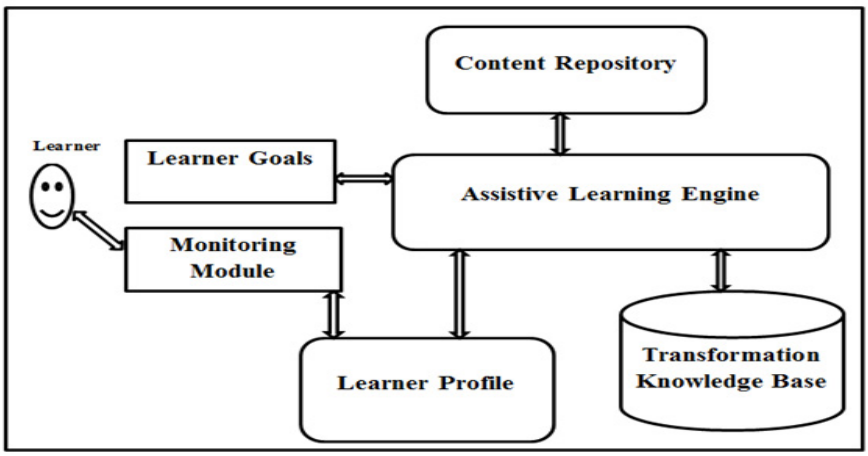

Fig 2. System Architecture

a) Content Repository

It is the main repository where the entire course material is stored. As we know that the content which has to be provided to LD learners have to be deeply personalized because the learner's requirement vary highly. The content repository must be able to capture some of the information like vocabulary, description, topics, media objects, language details etc. So we have created an XML based markup language to represent this content repository

b) Learner Profile

The Learner profile contains the following basic information like name, age, current level of education. From the above basic information, the learner vocabulary is derived which is in the form of very basic, basic, medium, advance and very advance. Now depending upon the learner vocabulary, its respective chapter vocabulary is extracted from the content repository. The learner profile also contains extra important information related to Learning Style like visual, aural, tactile etc, and learning problems in the areas of listening, speaking, reading, writing, spelling, reasoning and mathematics

c) Assistive Learning Engine (ALEG)

The ALEG plays vital role in the system architecture; as it is also known that, each LD learner will have its own way of learning things, so they have lots of accessibility issues while using the existing content. So it is necessary to transform the content from the content repository in the manner acceptable by the learner. This transformation has to be done in a sequence and structured way so that the LD learner get his personalized content, so we group them as shown in the fig. 3. There are three levels of transformation done by ALEG: Content Transformation, Pedagogy Transformation and Presentation Transformation.

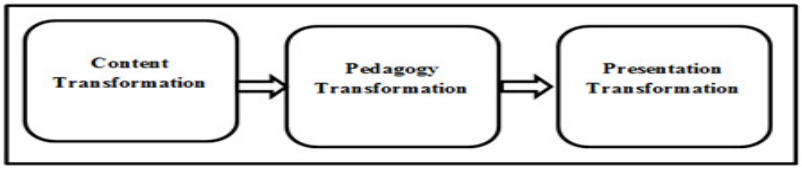

Fig. 3. Three level Transformations done by ALEG

The content transformation is the first level transformation done by ALEG. The aim of this transformation is to extract learner appropriate content from the content repository. This extraction is based on set of rules which are extracted from TKB.. So the learner's information like his name, age, standard, learning style and learning problems are extracted from the learner profile as shown in the fig. 4.

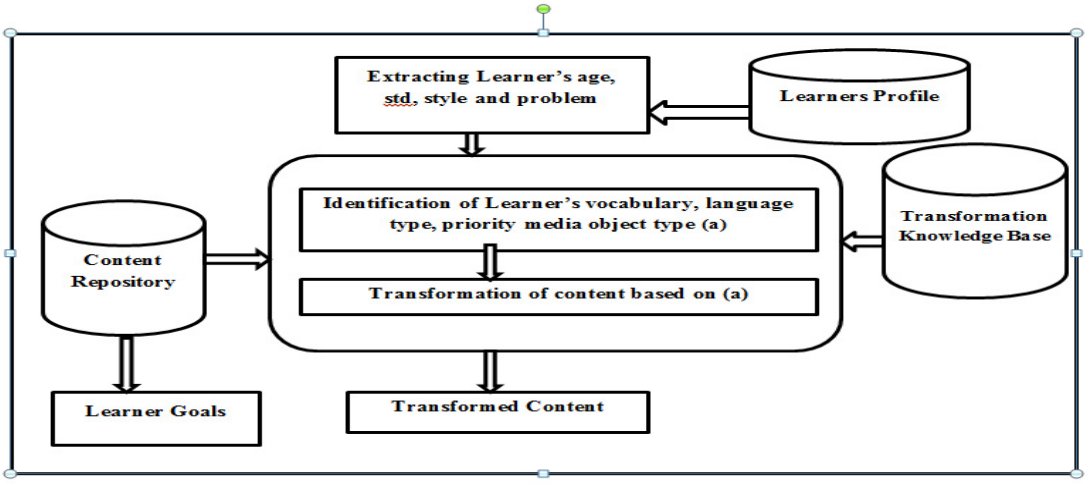

Fig. 4. Content Level Transformation

Now based on the information extracted from the learner profile, the first important stage to identify the learner's vocabulary, learner's language type and priority media object. The task performed in identifying learner's vocabulary is to consider learner's age and learner's std. The rule pattern is extracted from the TKB. The task involved in identifying learner's language is to consider only learner's age to extract the rule from TKB. And the job performed in identifying the priority media object is to consider the learning style extract the rule from TKB. Once the rule extraction is done from the TKB, the next stage is to extract the appropriate content and apply those rules on that content. When the learner logs in the system, he knows his current goals. This learner goal is the topic that he is going to learn. Based on the learner goals, appropriate con tent unit is extracted and all the rules of stage one are applied on the content extracted in the stage 2. And finally the content transformation has taken place

The aim of pedagogy transformation is to provide variation in the teaching method according to the LD learner's requirement. The output of the content transformation forms the input to the second level transformation i.e. pedagogy transformation as shown in the fig. 5.

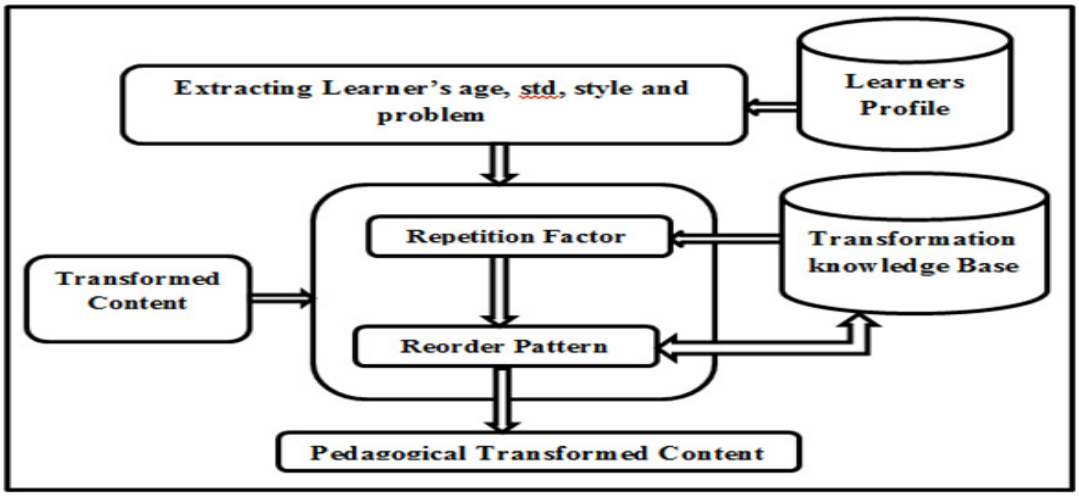

Fig 5. Pedagogy Level Transformation

Thus, we have transformed content from previous level and learner's information from the learner's bank which forms the input to the pedagogy transformation. There are two main task of pedagogical transformation- Repetition factor and Reorder Pattern. The job involved in Repetition factor is to find out number of times a particular part of the content is repeated. As we already that LD learner, have problem in understanding, remembering and grasping things. One of the easiest ways to make LD learner remember things is to repeat things number of times. Now based on the learner profile, available content, appropriate rule has to be extracted from the TKB which will be helpful for the LD learner. The job involved in Reorder Pattern is to find reorder pattern from the TKB. The reorder pattern decides the flow of teaching content. The same teaching pattern doesn't work out for all the type of LD learner, so it is necessary to shuffle the way of teaching. For e.g., one LD learner may find it feasible for him to follow the teaching pattern of definition, introduction and example. But for some pattern could be example, introduction and then definition. So this reordering of content helps LD learner to grasp things easily depending upon their learning styles. The output of this transformation is the pedagogical transformed content.

The learner information and output of previous level transformation forms the input to this last and final transformation as shown in the fig. 6. The aim of presentation transformation is to represent the content in such a format that the LD learner be very comfortable with it and can understand what exactly is taught to them. The presentation transformation deals with following task: Grid pattern, Spacing Pattern, Font Pattern, Dictionary Type Color pattern. This grid pattern is useful for those LD learners who have problem in mixing two adjoining words, or overlapping two neighboring alphabets or two lines. With the help of grids, a separation is provided between alphabets, words and lines. The exact requirement of the grid is extracted from TKB depending upon the LD learner requirements.

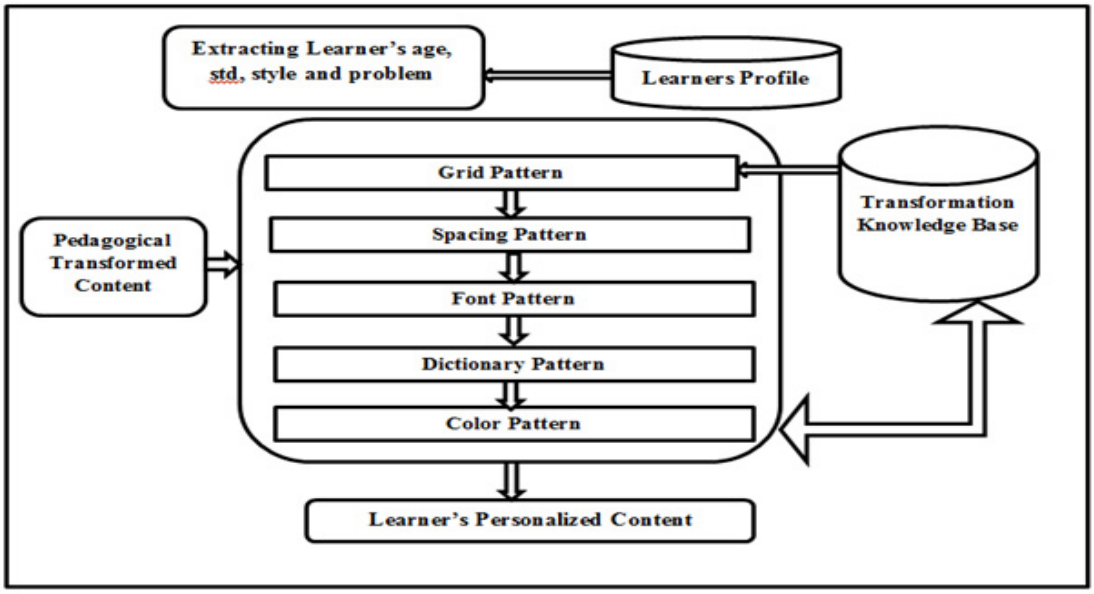

Fig.6. Presentation Level Transformation

The spacing pattern also helps LD learners to read alphabets, words easily and properly. Sometimes line spacing is also required by the LD learner. So depending upon the LD problem, appropriate rule is extracted from the TKB. The Font Pattern plays vital role in the presentation formats because LD learner's are not comfortable with all the font types. They prefer fonts like Tahoma, Gothic etc. the exact rules of font type, size and its alignment are extracted from TKB. As majority of LD learner have very low vocabulary, they do not know the meaning of all the word present in the content, so dictionary is provided to provide their meanings. Also it has three types of dictionary like normal text dictionary, image dictionary and sound dictionary. Depending upon the learning style of the LD learner, appropriate rule is extracted from the TKB. The task involved in is Color pattern. The background, foreground and the font color plays important role in the presentation formats. So depending upon the LD learner's requirement, appropriate colors rules are extracted from the TKB. So depending upon the learner profile appropriate extractions are done from TKB. And the output of this transformation is the personalized content of the LD learner.

d) Transformation Knowledge Base (TKB)

The goal of Transformation Knowledge Base (TKB) is to acquire the given content and identify the type of transformation applicable for each LD learner. To perform the above goal, the TKB performs two important jobs: filtering the content and enriching format. The task performed in filtering the content is to identify what content has to be filtered, when the content is filtering process going to start and for whom is the filtering process applicable. The task involved in enriching format is to identify enriching format that will make the content accessible to the learner. All this information is captured in the TKB. As we have already seen in detail various levels of transformation. In order to implement that transformation, the TKB is required. It deals with set of rules to perform that implementation

e) Learners Goal

The learner goal deals with the topic that the learner has to study in that session. Based on the learner goals appropriate content unit is extracted from the content repository and goes to three level transformations which we have already studied.

f) Monitoring Module

The main purpose of the monitoring module is to provide the teacher and parent the information related to the LD learner as well as the progress of the learner as in, the number of topics completed as well as number of topics remaining.

3. Implementation of the System

For the purpose of this paper, an Assistive e-Learning system that provides online tutorials for LD learner is developed. Two "Chapters" are created manually by the author; each combines about six topics. The system is primarily build on the above architecture based on the content transformation depending upon the requirement of LD learner. In this section, we provide a walkthrough of our Assistive E-Learning system with its experimental evaluation.

The Assistive E-Learning system is developed using tools like PHP, XML and HTML. We have used the services of WAMP Server which allows to set up a server locally on their machine to create dynamic web applications in the same development conditions as on the production server. Providing the course content to the learner according to its requirement is an important aspect at the time of implementation. The course content is stored in the content repository using XML as shown in the fig 7.

```
<?xml version="1.0" encoding="UTF-8"?>
<chapter-root>
  <chapter_info Chapter_Id="VBC1" Chapter_Vocabulory="basic" Chapter_Title="Introduction to Human Body">
  <chapter_description> This lesson  will help us to know our bodies . God made our human body. .</chapter_description>
  <chapter_topics>  The chapter is divided into following five topics: topic 1 The Cell topic 2 The Brain topic 3  The Muscles
  </chapter_topics>
    <topic id="T1" type="Concept" title="The Cell">
    <topic_definition type="formal">
      <mediaobject type="textobject">
        <phrase>The cell is key unit of all humans which are made of atoms. </phrase></mediaobject>
      <mediaobject type="audioobject">
        <audioobject filename="c:\introductiontocell.mp4"  format="mp4" caption="introduction to cell" end_time="4.00" start_time="0.00">
          <phrase>. The cell is key unit of all humans which are made of atoms.  </phrase>
        </audioobject></mediaobject>
    </topic_definition>
    <topic_introduction>
      <mediaobject type="textobject">

        <phrase> Dear student , Each part of our body made of cells. They work full day and night . There are many cells in our
        body</phrase>
      </mediaobject>
      <mediaobject type="imageobject">
        <imageobject fileref="cell.jpeg" format="jpeg" caption=" The cell">
          <phrase>Dear student see the photo, Each part of our body made of cells . They work full day and  night .  </phrase>
        </imageobject>
      </mediaobject>
    </topic_introduction>
  </topic>
```

Fig.7. Sample Content

The feedback form is individualized for each learner. It is divided into three sections General Question Section, which is common for all the learners, the learner specific question section which is concentrating on the learner's experience with the provided content format and additional assistive features Required at each transformation level. This section measures the learning experience of the learner who requires additional amendments in the existing presented content. For e.g. if the learner is facing difficulty in understanding the meaning of the words in the existing content, he can enable the dictionary for his next learning session. The learner feedback details are stored and a summary report is generated after five learning sessions.. Based on the summary report, appropriate changes are reflected in the transformation rules by human expert interface as shown in the fig. 8. The summary report provides the learner profile is along with the transformation provided by the Assistive E-Learning System. It also provides the feedback details in percentage and in this case, additional assistive features is required at each level i.e. additional required of alphabet spacing, word spacing and dictionary is required at the presentation level. At the pedagogical level, there is requirement to decrease the frequency of the repetition of the topic. And at the content level, there is desire to decrease the vocabulary level.

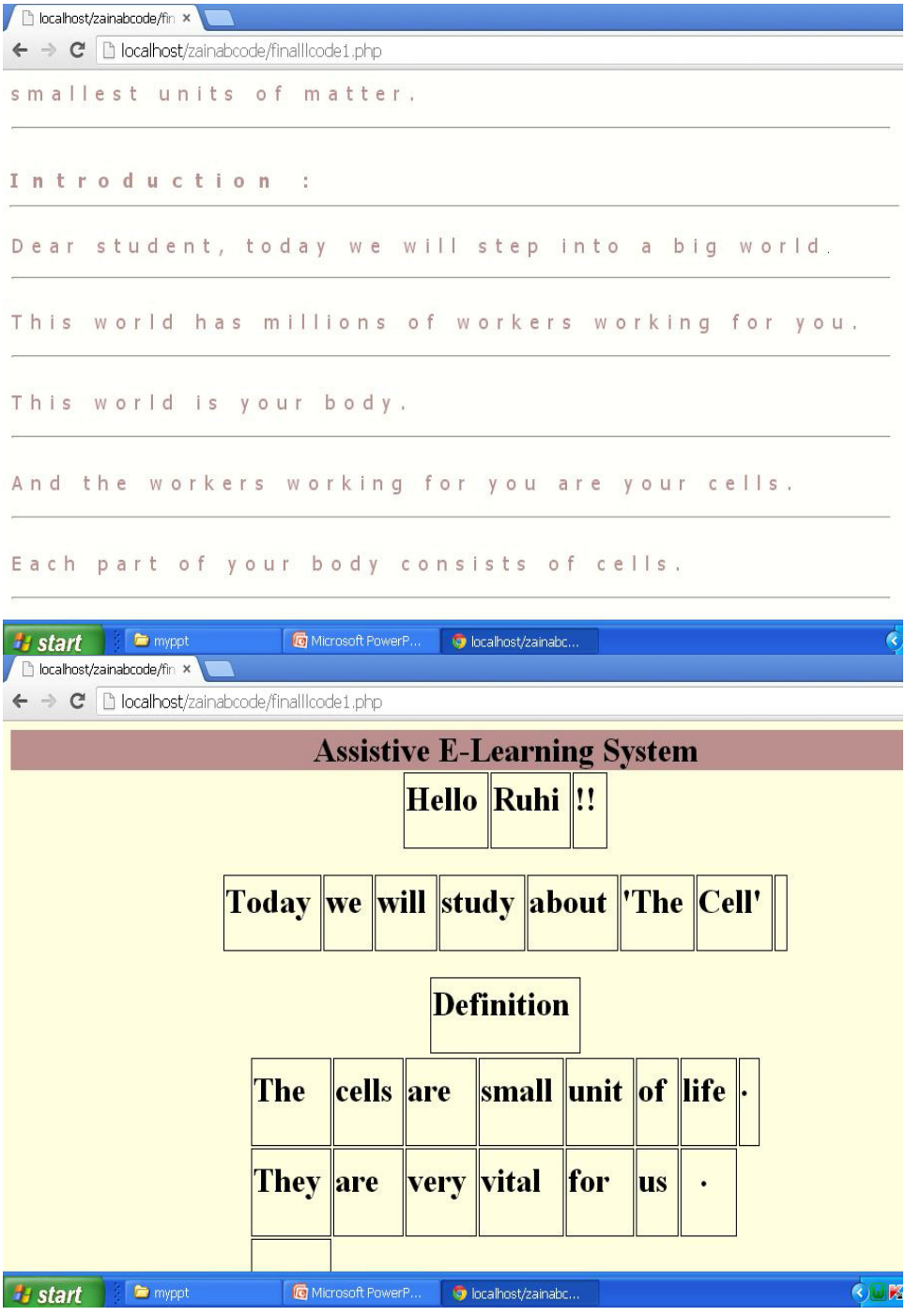

Fig. 8. Output of Learner Mode

4. Conclusion

The overall approach followed in the paper is to mimic the way a LD learner learns in an assistive learning environment, where direct emphasis is given on content presentation according to the requirement of the LD learner. A prototype for the entire system – named Assistive E-Learning System has been done, and preliminary studies show encouraging results. The system has a generic architecture that is currently tuned for assisting LD learners. It contains rich repository dealing with various subjects, which are further divided into various chapters, which are re-divided into various topics, with different vocabulary and language type. The system has enormous number of rules to provide LD learner with appropriate lesson depending upon his requirement.

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